UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

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NRC INFORMATION NOTICE 2002-12: SUBMERGED SAFETY-RELATED ELECTRICAL CABLES

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to inform addressees of observed protracted submergence in water of electrical cables that feed safety-related equipment. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On November 11, 2001, at the Oyster Creek Nuclear Power Plant, a 4160-Vac cable failure deenergized a unit substation for the 480-Vac system, prompting unit shutdown. The licensee replaced the faulted Anaconda Unishield cable with a Cablec cable and conducted a root cause evaluation. On the basis of that evaluation, the licensee concluded that the cable failure resulted from a localized delamination of the cable jacket aggravated by water intrusion into the underground cable conduit, subsequent cable drying, and corona degradation of the insulation [Licensee Event Report 50-219/2001-01, dated January 7, 2002].

NRC inspectors reviewed similar concerns at Pilgrim Nuclear Power Station (Inspection Report 50-293/01-05), Millstone Nuclear Power Station Unit 2 (no inspection report generated), and Beaver Valley Power Station (Inspection Report 50-334/01-09). At Pilgrim, the inspectors identified one issue of very low safety significance (Green), finding that safety-related cables located inside manholes were submerged in water for an extended period of time. Although not a specific violation of NRC requirements, this was a notable weakness given that the licensee did not have a routine monitoring and inspection program for these underground cables. At both Millstone Unit 2 and Beaver Valley, the inspectors observed submerged safety-related cables, but learned that the cables were designed to withstand such submergence.

On August 30, 2000, at the Brunswick Steam Electric Plant, NRC inspectors toured a system of underground manholes and found safety-related electrical cables, including electrical splices, submerged in water. In addition, the inspectors observed leaking ductbanks, corroded and

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broken cable supports, cable jacket tears, inoperable sump pumps, and inoperable level control circuits. Prior to that inspection, on January 21, 1999, the Brunswick licensee inspected one of the manholes in this system, found adverse conditions, and classified the entire system of 57 manholes in Maintenance Rule (MR) a(1) status. That classification refers to *Title 10 of the Code of Federal Regulations* (10 CFR), Section 50.65(a)(1), which requires monitoring of the performance or condition of a system against licensee-established goals to reasonably ensure that the system can satisfy its intended function (NRC Inspection Report 50-325/2000-04, dated October 27, 2000).

On October 2, 1999, at Davis-Besse, a component cooling water pump tripped as a result of a phase-to-ground fault on a medium-voltage 3-phase power cable. The specific cable in question was installed in a 4-inch polyvinyl chloride (PVC) conduit, which runs partially underground, and had been in service for 23 years.

Discussion

Oyster Creek Nuclear Power Plant

The licensee determined that the safety significance of this event was minimal because the redundant electrical power source remained operable and because no functional failure of any safety system occurred. After replacing the failed portion of the cable and making necessary repairs, the licensee brought the plant back up to power. In the long term, the licensee is evaluating replacement cables that are extruded and manufactured with modern techniques and the use of above-ground cable trays for its medium voltage electrical distribution system.

Brunswick Steam Electric Plant

The licensee established a manhole restoration project to restore the material condition of the electrical manholes, including those with cabling addressed by the Maintenance Rule. Using risk assessment techniques to schedule the restorations, the licensee restored 52 manholes to varying degrees over a period of more than one year, satisfying the goals of (1) inspecting and repairing degraded cable and (2) minimizing water leakage into plant structures and manholes to prevent corrosion of cable supports and components.

Licensee corrective actions included (1) identifying and repairing degraded protective cable jackets, (2) cleaning or coating corroded cable supports or components, (3) addressing leakage of rainwater or groundwater by replacing the seals of duct banks entering manholes or plant structures and installing plastic inserts under manhole covers to divert accumulating rainwater away from the manholes, (4) replacing sump pumps and switch mechanisms as needed, and (5) adding check valves to sump pump discharge piping to prevent rainwater from backing up into manholes.

The licensee is currently evaluating the effectiveness of this project. To date, the licensee has not identified water leakage from manholes in plant buildings.

Davis-Besse Nuclear Power Station

In determining the root cause of the medium-voltage cable failure, the licensee theorized that water in the conduit gradually penetrated the outer neoprene cable jacket, migrated through the cloth binder tape just inside the jacket and through the various layers of the cable construction, and finally penetrated the ethylene propylene rubber (EPR) insulation by osmosis. The water seeping into the cable layers likely contained impurities that precipitated in the outer region of the EPR. Because the conductor was off-centered, precipitation of these impurities presumably disturbed the electric field in the jacket material. The accompanying observed cracking and conversion of the jacket material to carbon may have released additional impurities that would have further degraded the cable. Breakdown of the insulation would be most concentrated in the regions of the highest electric field intensity produced by the current in the conductor. However, this scenario has not been confirmed.

The licensee successfully tested the cables of the other two component cooling water pumps and the associated makeup pumps. On the basis of these tests, the licensee concluded that the ground was an isolated fault.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate project manager from the NRC's Office of Nuclear Reactor Regulation (NRR).

/RA/

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